JPL / SpaceX

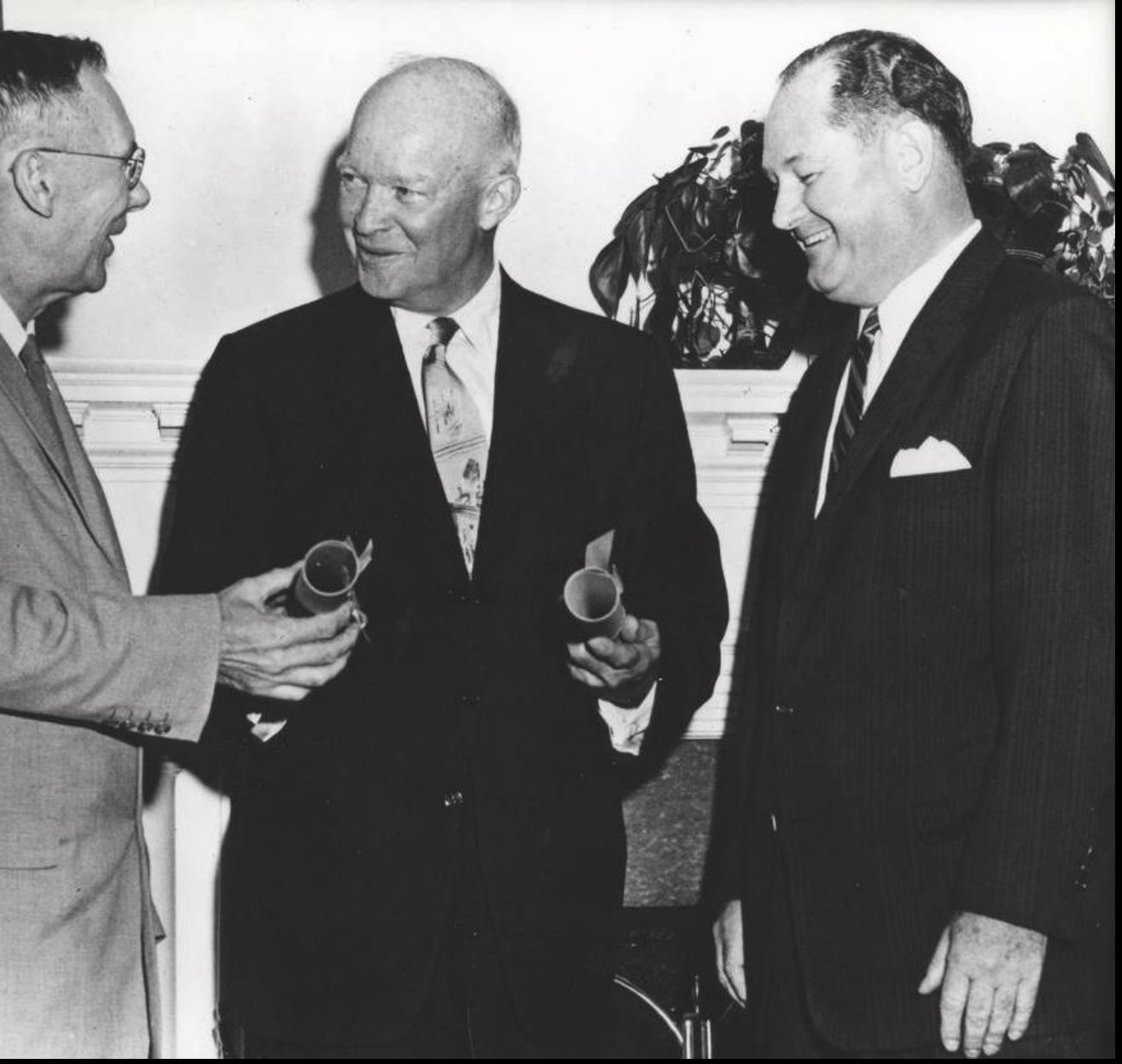
Mechanism Engineering Cultural Exchange Program

Jet Propulsion Laboratory
California Institute of Technology

Matt Heverly
3/30/2017

JPL was founded in **1943** and in **1944** started building rockets for a military contract
Private (bottom) and Corporal (top) rockets

1958 Explorer 1 – first U.S. satellite



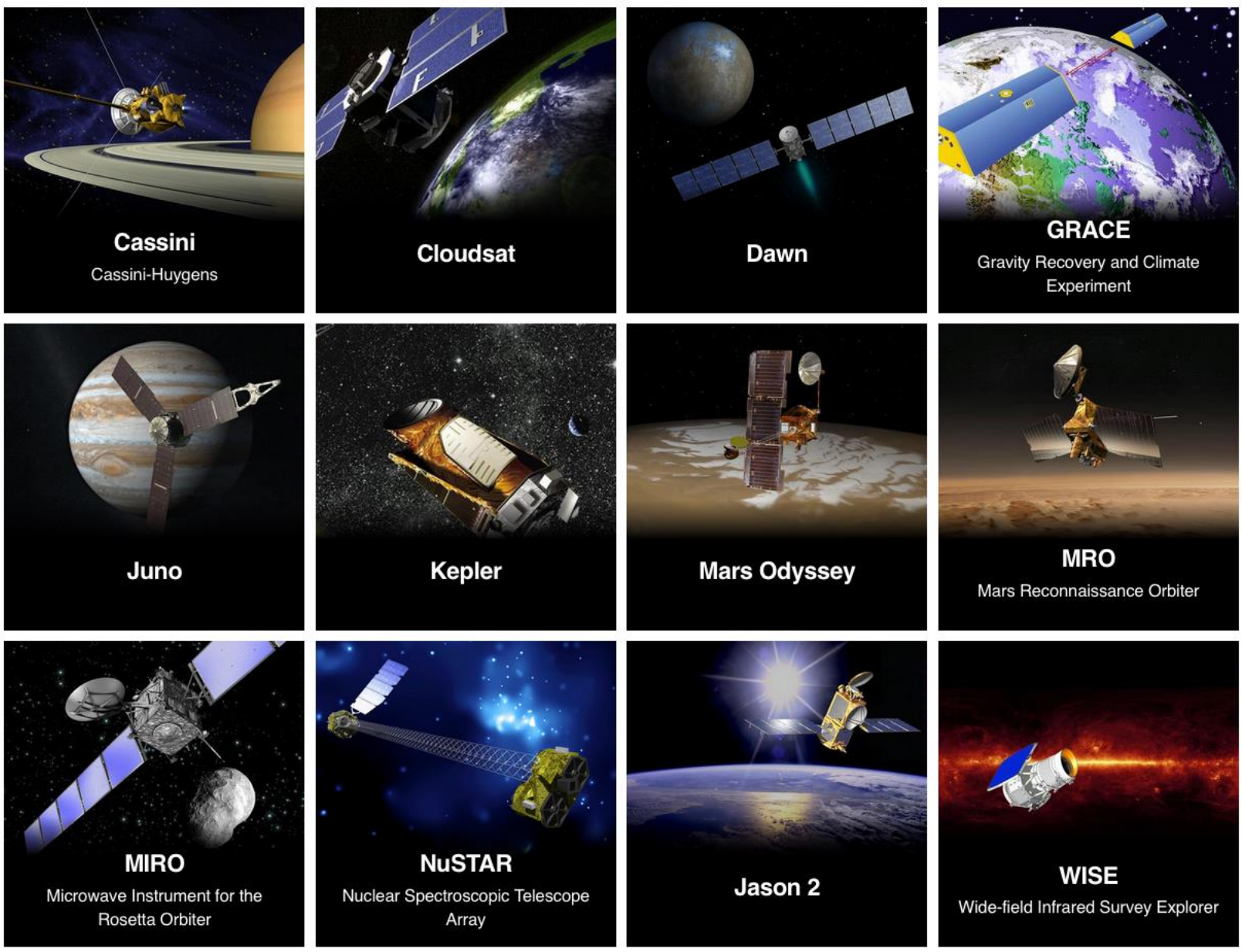
1958 NASA created

JPL is one of 10 NASA center in the U.S. and is managed by **Caltech**

Jet Propulsion Laboratory
California Institute of Technology

Our charter is robotic space and Earth **science** missions

19 operational spacecraft and 2 rovers



19 operational spacecraft and 2 rovers

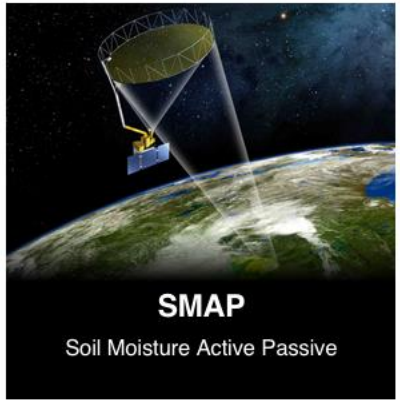
Voyager 1

Spitzer Space Telescope

OCO-2

Orbiting Carbon Observatory 2

Voyager 2



SMAP

Soil Moisture Active Passive

Jason 3

NEOWISE

NEOWISE

MER

Mars Exploration Rover - Opportunity

MSL

Mars Science Laboratory Curiosity Rover


NASA


NASA

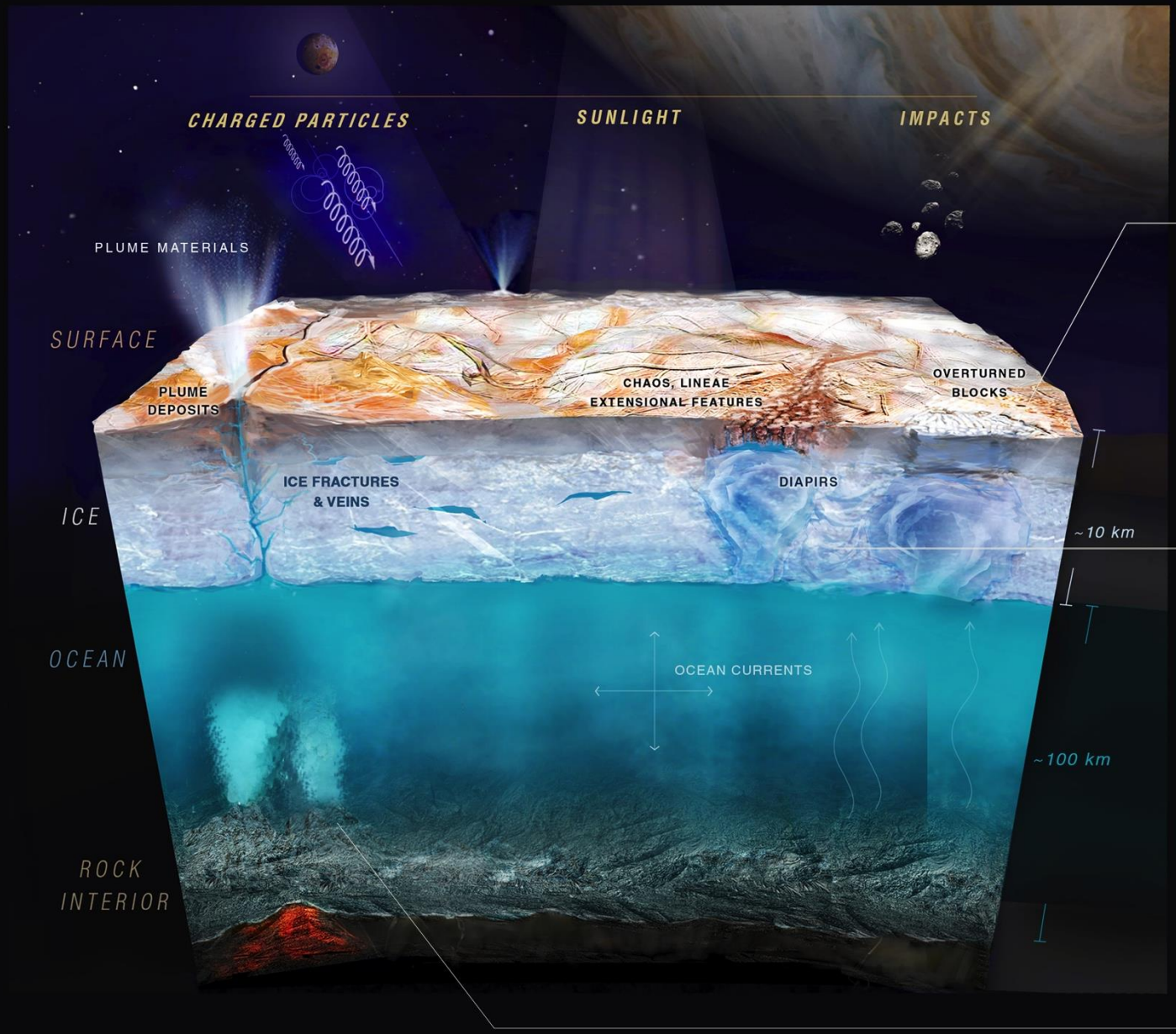

NASA

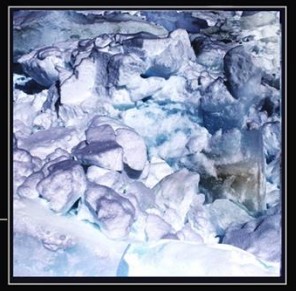
Mechanisms and Mobility

Charter: Design, development, and execution of world-class spacecraft mechanisms from "cradle to grave". Implementing planetary mobility systems and creating enabling technology.

Europa Lander Concept

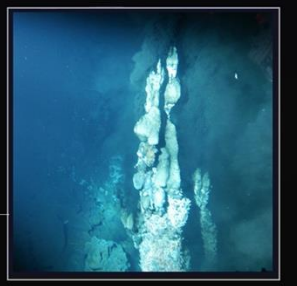
EUROPA



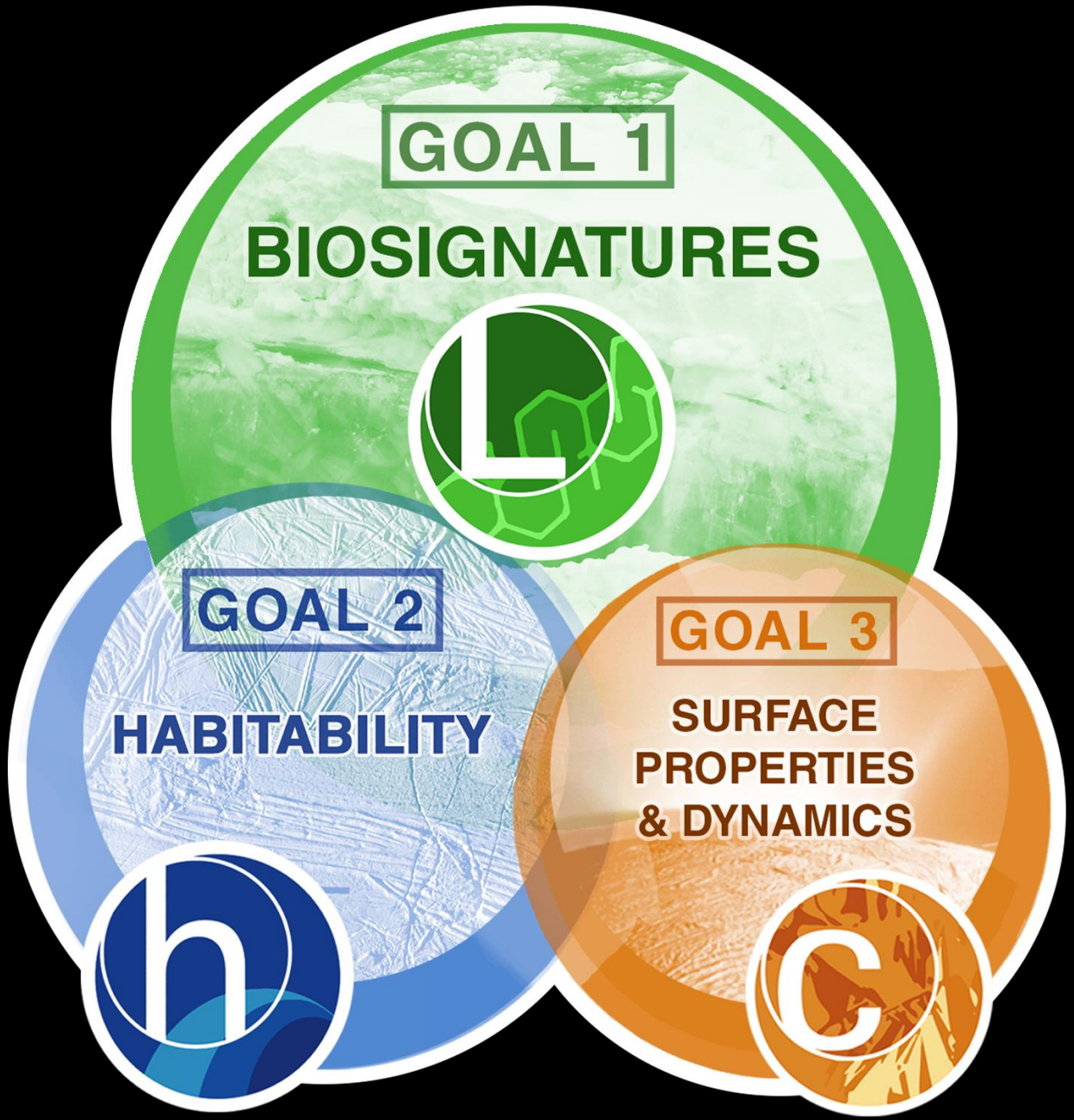


ICE BLOCKS

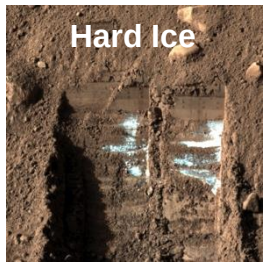
ICE FRACTURES

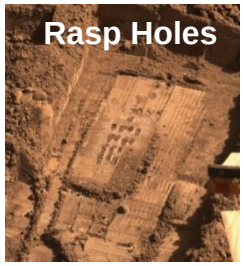


HYDROTHERMAL VENTS



Europa Lander Concept



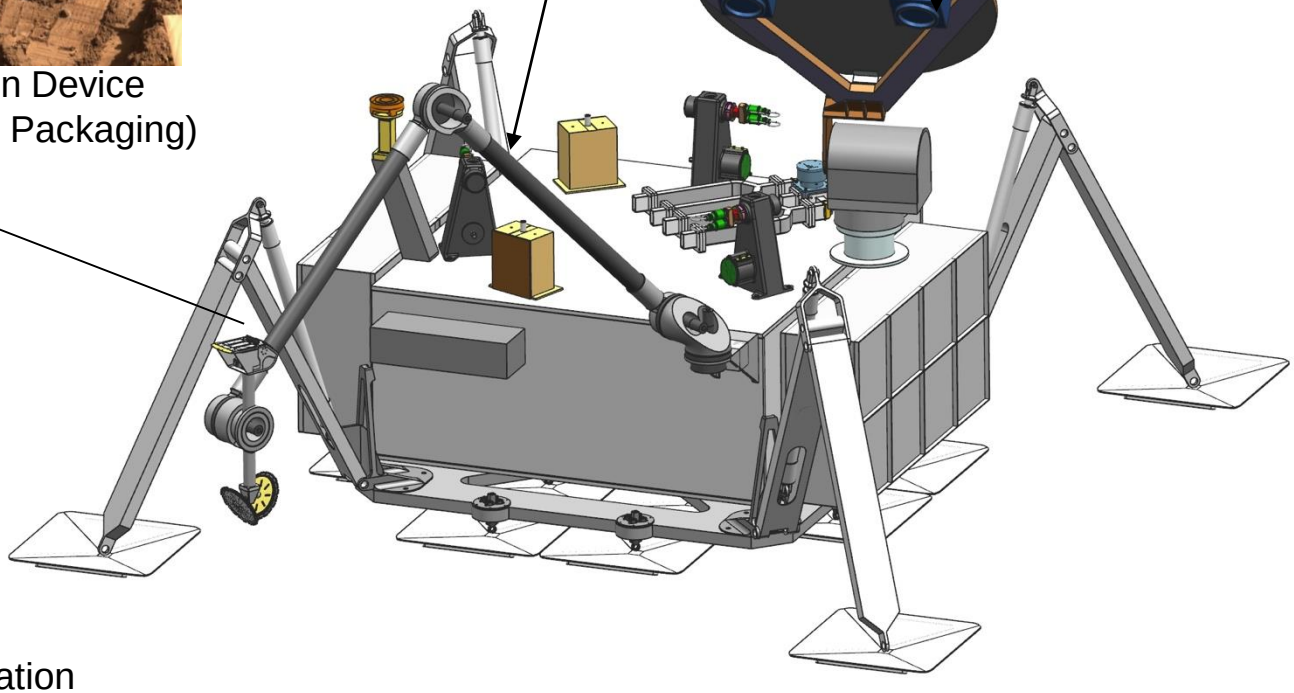


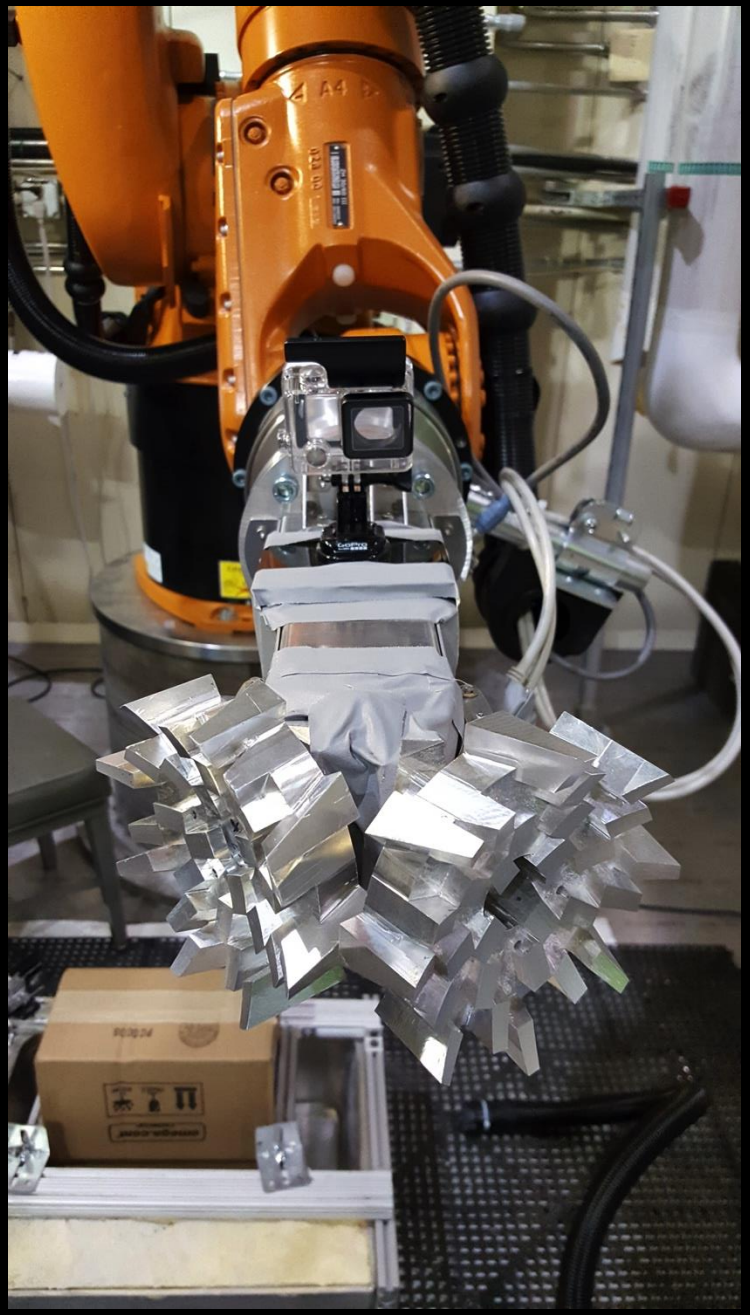
Sample Collection Device
(Phoenix Heritage + Packaging)

Robotic
Arm

Stereo Imagers (Payload)

Sample Excavation
Tool



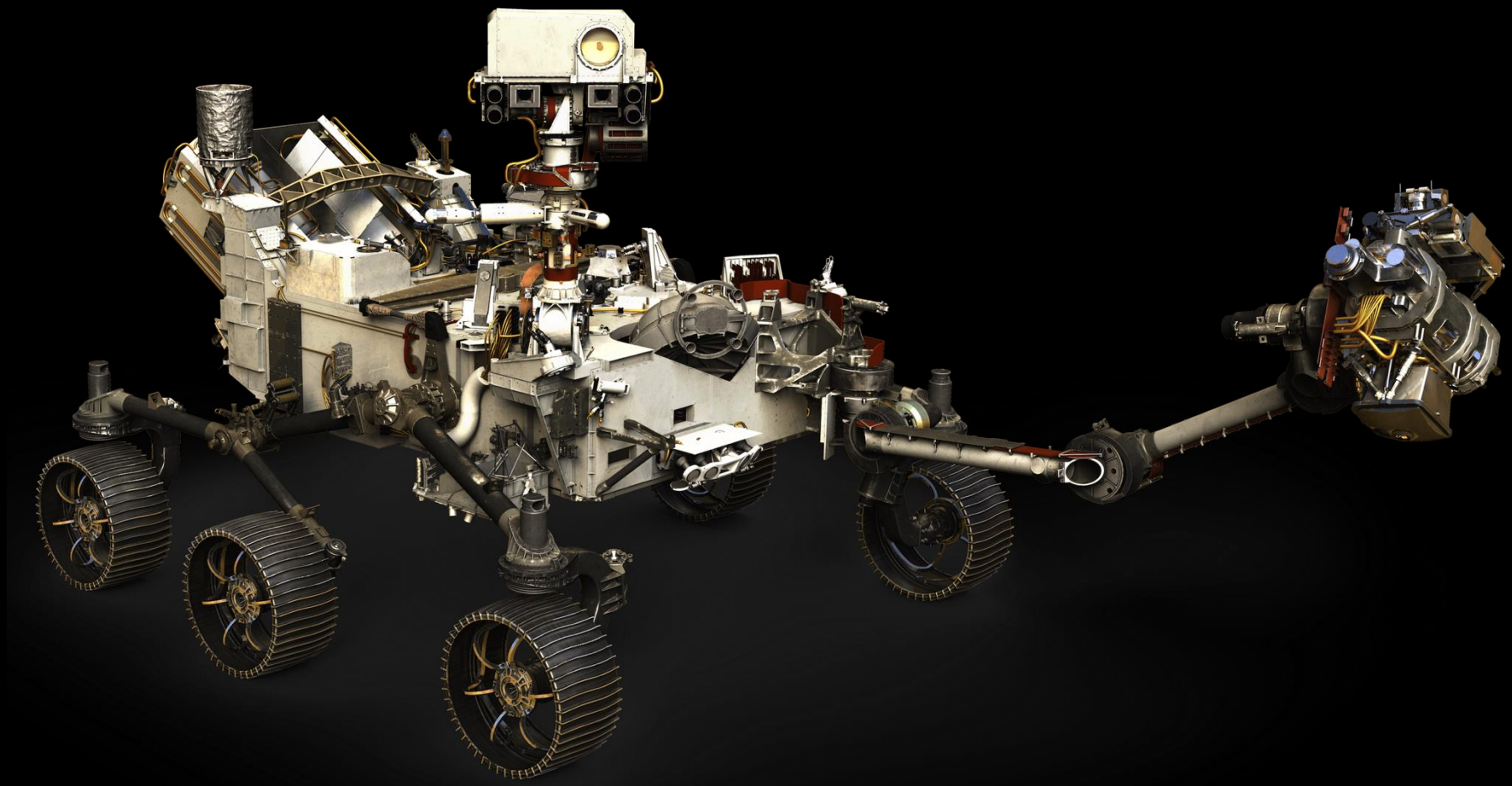



Cutting porous material (grill brick)


Trenching loose material

The Mars 2020 Rover:

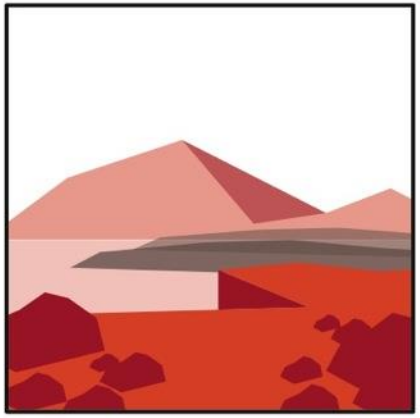
Seeking Signs of Past Life on Mars



Understanding the Possibilities for Life on Mars

Ancient Microbial Life + Human Life

OBJECTIVE A:
Geology

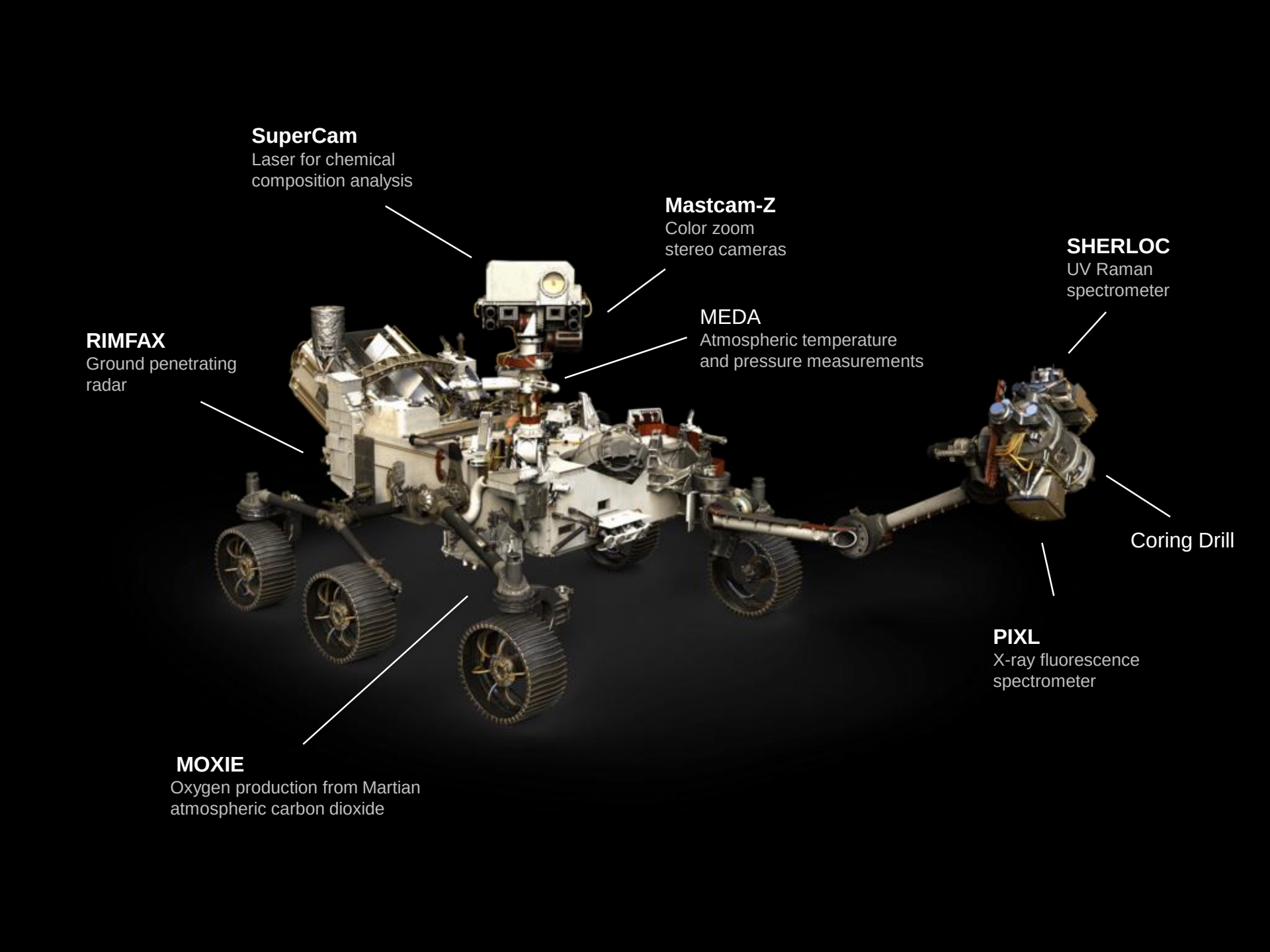


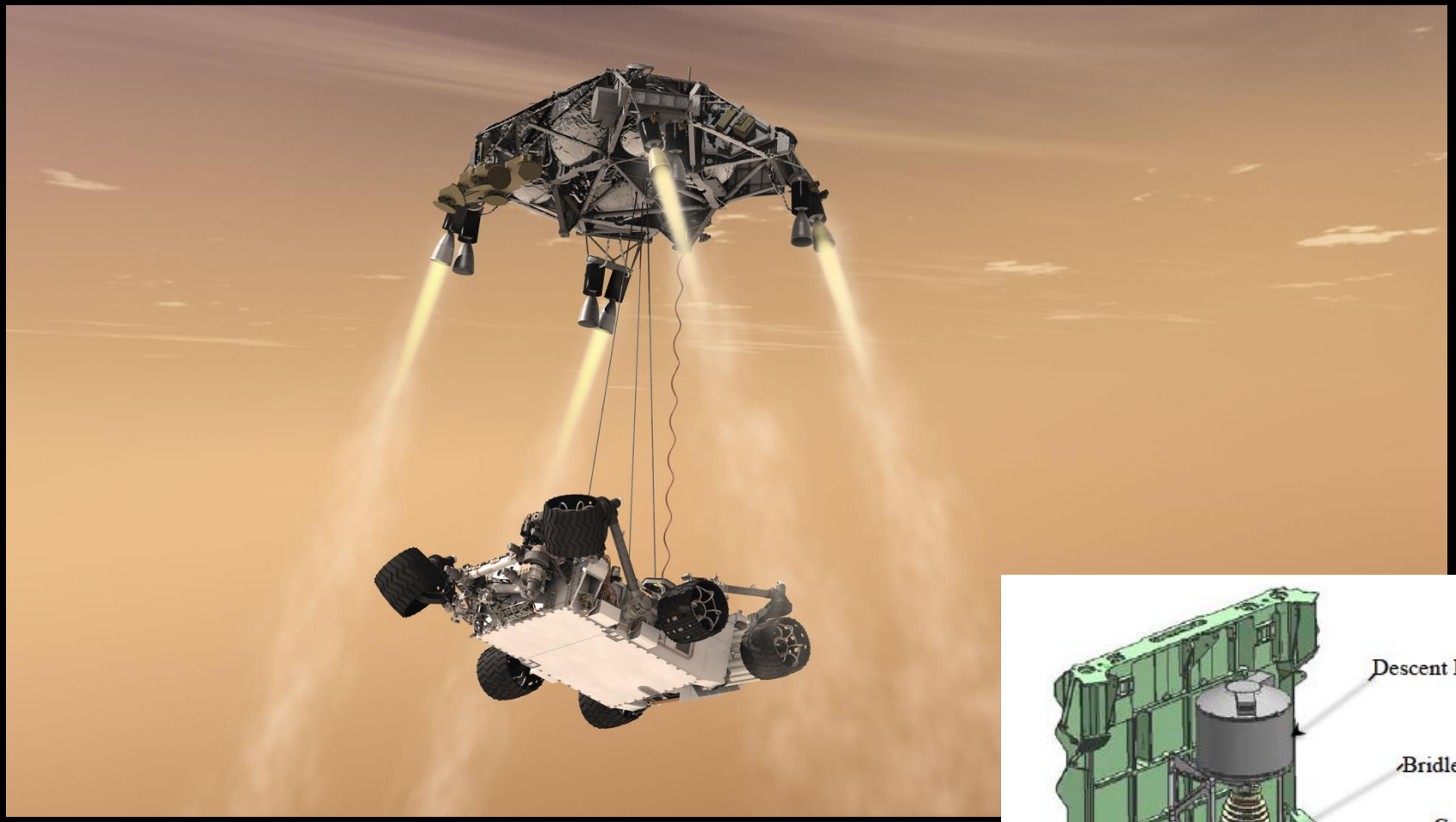
OBJECTIVE B:
Astrobiology

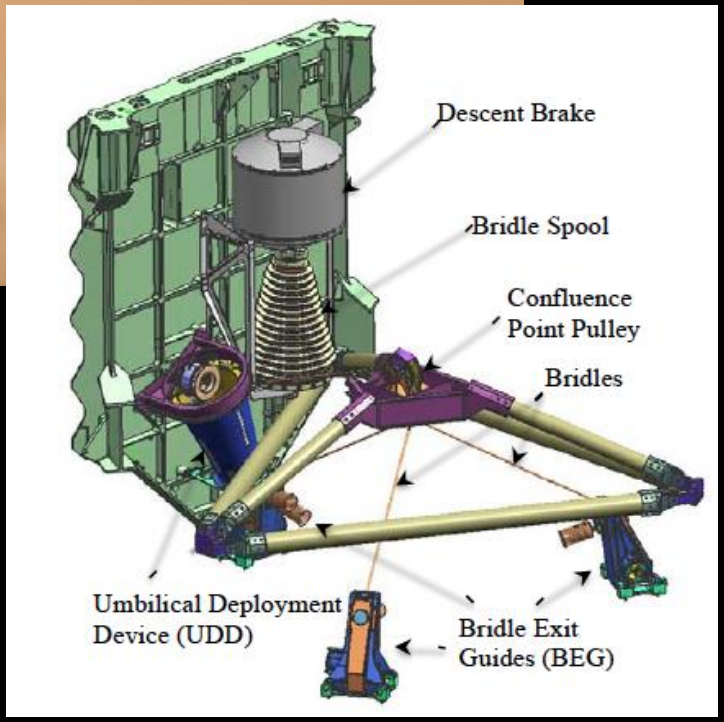
OBJECTIVE C:
Sampling

+

OBJECTIVE D:
Prepare for Humans

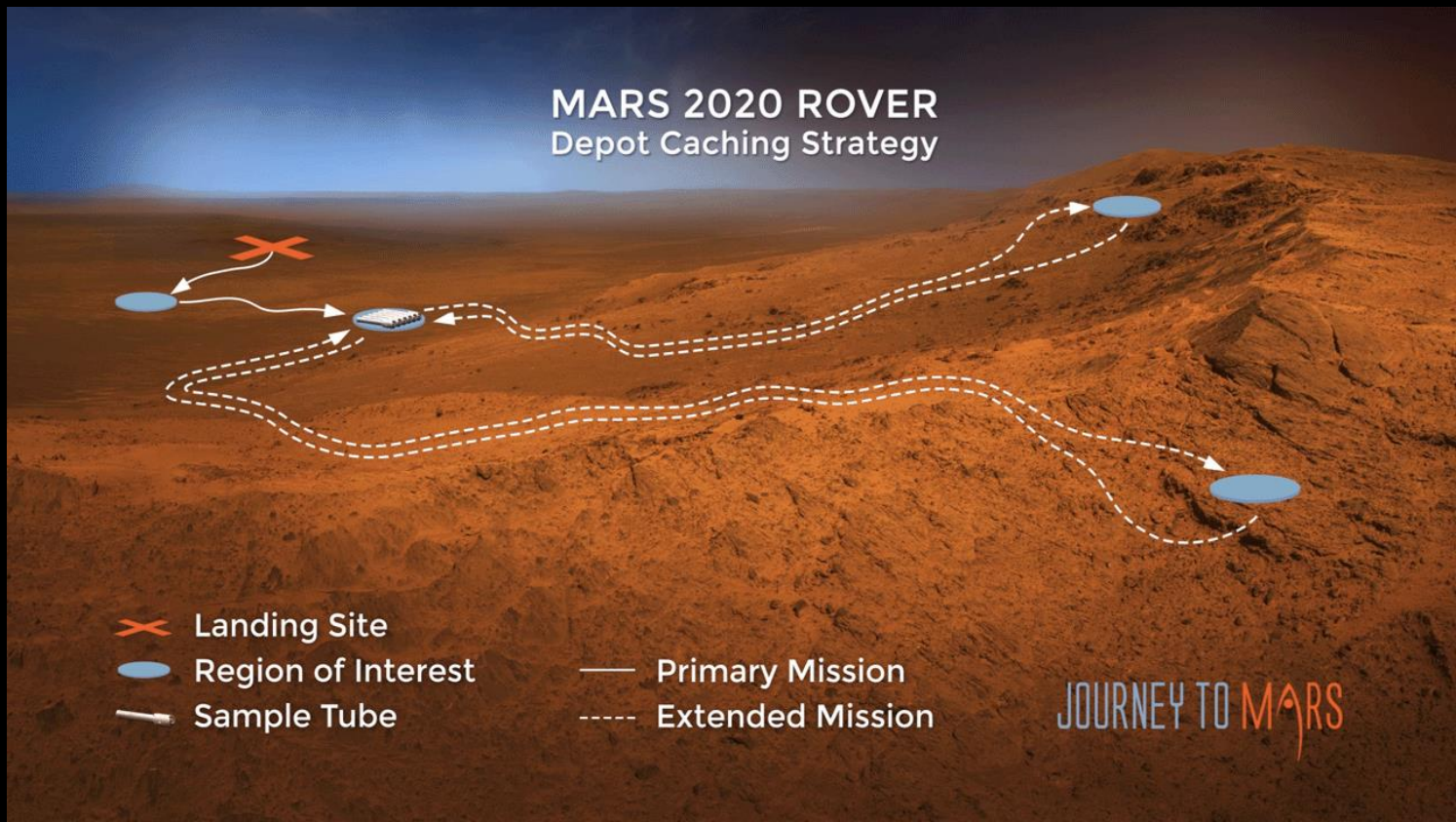

SuperCam
Laser for chemical composition analysis
Mastcam-Z
Color zoom stereo cameras
SHERLOC
UV Raman spectrometer
MEDA
Atmospheric temperature and pressure measurements
RIMFAX
Ground penetrating radar
Coring Drill
PIXL
X-ray fluorescence spectrometer
MOXIE
Oxygen production from Martian atmospheric carbon dioxide



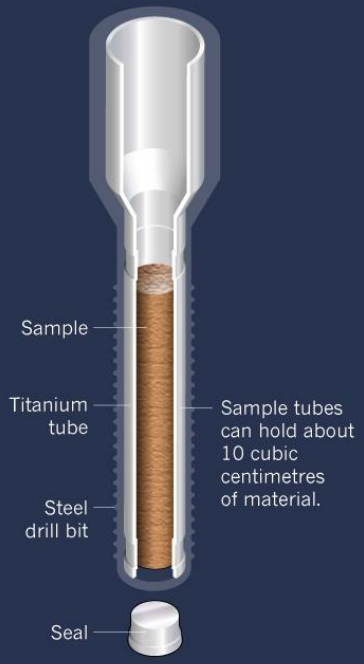


Bridle and Umbilical Device (BUD) image courtesy of
Gallon, John, “Verification and Validation Testing of the Bridle and Umbilical Device for Mars Science Laboratory,” presented at the IEEE Aerospace Conference, Big Sky, MT, 2012.

- Caching Samples is one of the four science objectives of the Mars 2020 rover mission
  - Collect core rock and soil samples and store them on the Martian surface for possible return to Earth by a future mission
- Adaptive Caching Assembly supports depot caching approach
  - Stores, manipulates, hermetically seals, and deposits sample tubes on the Martian surface
  - Sample Handling Assembly, in development by MDA, manipulates the sample tubes
  - Assembly is located within the front of the rover

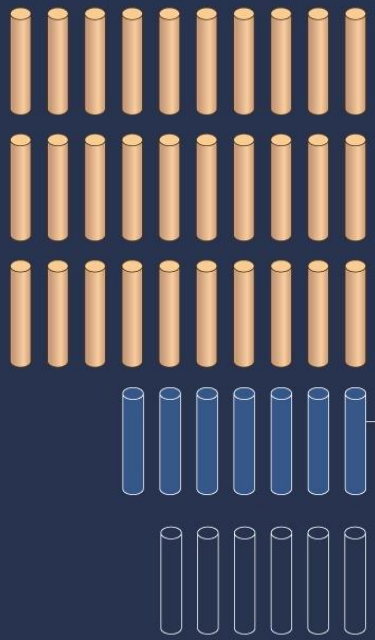


SAMPLING AND CACHING



The sampling system will use steel drill bits, with teeth made of tungsten carbide, to drill into rocks. It can drill in a percussive mode, like a jackhammer, or in a rotary mode. Once collected, the 15-gram sample will slide into a 14-centimetre-long titanium tube and be hermetically sealed to keep it pristine. The robotic arm will then swing back to the rover's body and deposit the sample tube in a carousel.

43 sample tubes carried aboard the rover

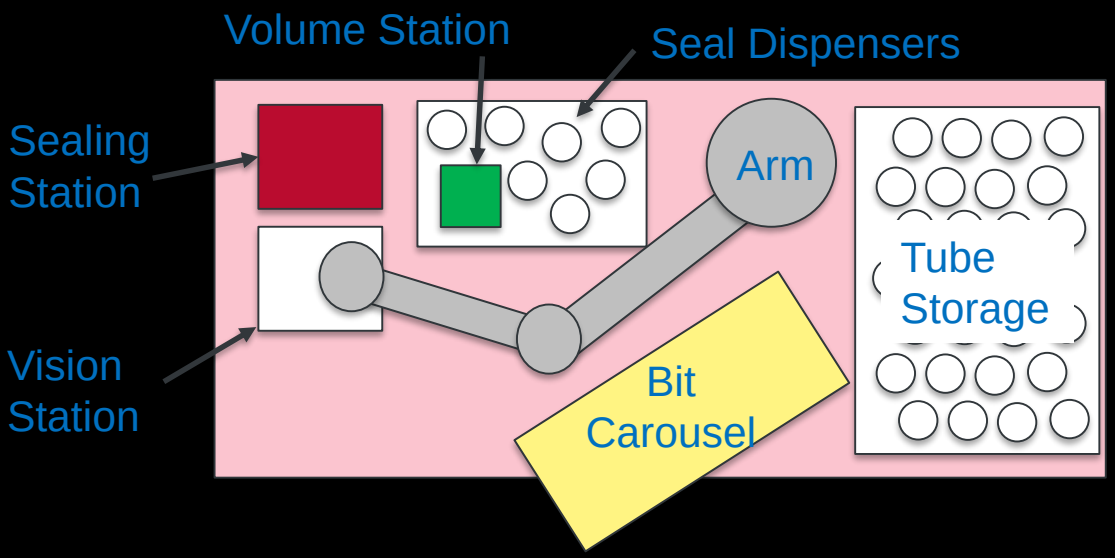


37 filled with rock/dirt sample, or atmospheric contamination as a 'witness tube'

6 spares

Once core samples are collected in tubes and brought inside the Rover into the Adaptive Caching Assembly via the Bit Carousel, a mini-robotic arm moved the tube to several stations:

- **Vision Station:** a camera takes images of the core in the tube
- **Volume Assessment Station**: a volume measurement is taken of the core
- **Seal Dispenser**: a seal is dispensed into the tube
- **Sealing Station**: the seal is activated to create a hermetic seal
- **Tube Storage:** the tube is stored until the decision is made to drop the tube on the surface of Mars

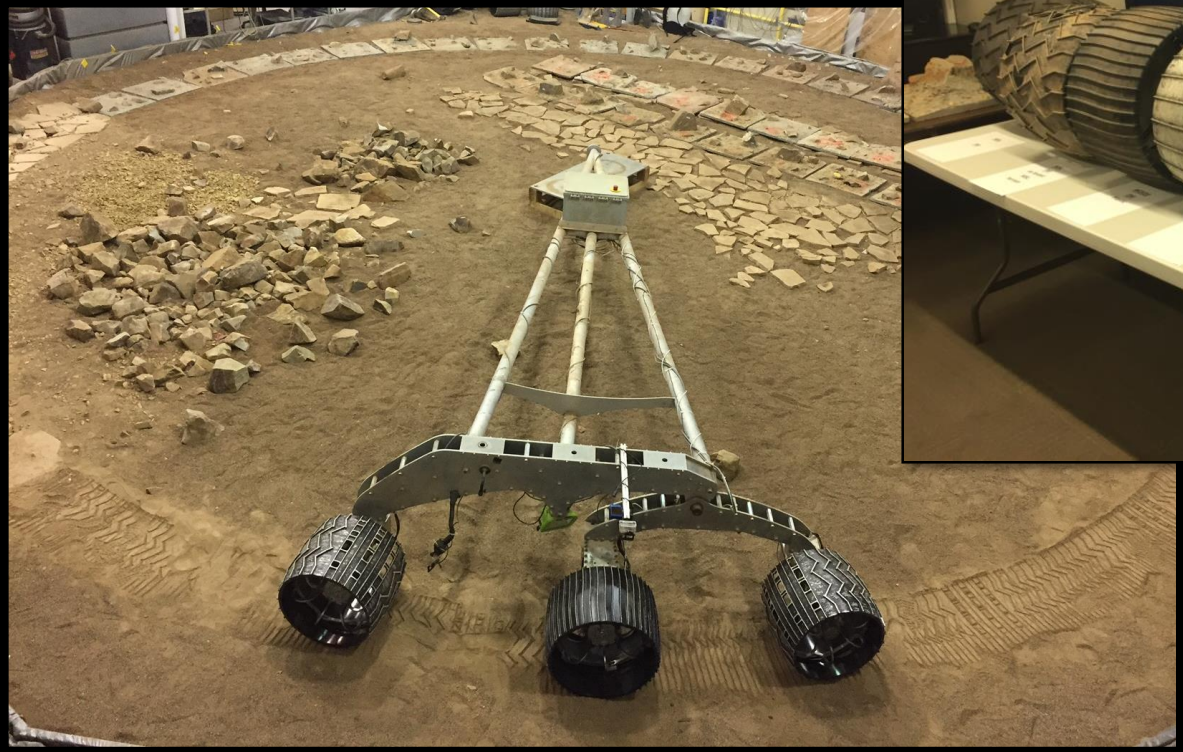


(a) Seal protruding from the top of the tube
(b) Example of a core inside of the tube

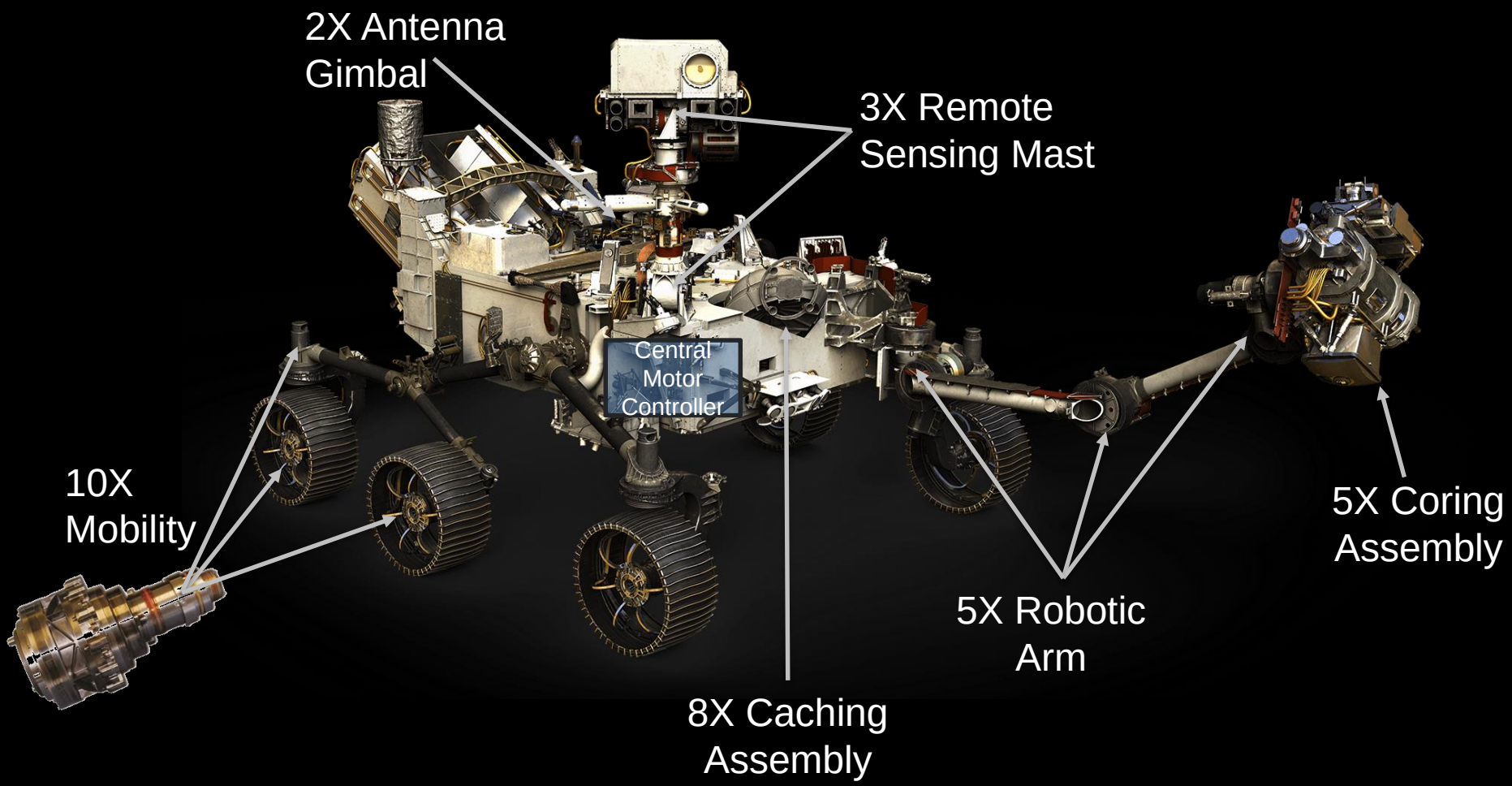
https://eos.org/project-updates/seeking-signs-of-life-and-more-nasas-mars-2020-mission

SHOWING OFF NEW WHEELS

More durable - thicker, more advanced aluminum
Better traction - new tread pattern for steeper climbing
Modified shape - reduced width to allow larger diameter, maximizing performance



M2020 Rover Motion Control: Actuators + Motor Controller



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